# Space Weather Technical Forecast

Issued on Saturday, 21 May 2022 at 01:24 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

## Space Weather Forecast Headline: R1-R2 Radio Blackouts likely. Slight chance R3 Radio blackouts from AR3014.

## Analysis of Space Weather Activity over past 24 hours

**Solar Activity:** Solar activity has been Moderate in the last 24 hours with an isolated M-class flare observed, peaking at 20/0745 UTC from AR3014 Ekc/Beta-Gamma-Delta. This region is the largest and the most complex, with significant delta spot and a large penumbra. Despite its size and magnetic complexity, it is not showing signs of growth and appears to be mature and stable. There are six other sunspot regions on the Earth-facing disc, which are much smaller in size and magnetic less complex, and are generally stable or diminishing apart for AR3019 which has shown some slight growth in area and spot number. No Earth directed CME's have been analysed, but a long duration C-class flare from AR3011 around 20/1300 UTC produced a weak CME. If adequate imagery is available an analysis will be undertaken to determine if the CME is Earth directed.

**Solar Wind / Geomagnetic Activity:** The solar wind, as measured by DSCOVR at L1 remained predominantly at elevated levels, approximately 540-580 km/s, but peaked at strong levels at 20/1541 UTC at 608 km/s. This was under the influence of a high speed stream from CH82 in the western hemisphere of the Sun. The solar wind density was mostly at average levels, occasionally temporarily reaching above average values. The interplanetary magnetic field (IMF) Bt, ranged between 5 to 7 nT. The north-south component remained weak, varying erratically between +5 and -6nT with no obvious pattern. The phi angle was mainly positive (away from the Sun). Geomagnetic activity was Quiet to Unsettled (Kp 2-3).

**Energetic Particles / Solar Radiation:** The high energy proton flux (10 MeV) has been at Background levels through the last 24 hours. The high energy electron flux (greater than 2 MeV) was at Normal Background levels, with the corresponding electron fluence well below the Active (1e8 integrated pfu). Observed fluence at 21/0000 UTC was 2.84e6 integrated pfu.

## Four-Day Space Weather Forecast Summary

**Solar Activity:** Solar activity is likely to be Moderate, with further M-class flares, and a slight chance of an isolated Strong-class flare (R3 Radio Blackout). The main source of the activity is likely to be from AR3014, although some significant flaring is also possible from AR3019, with a lower chance from the remaining regions. A couple of large filaments can also be observed on or approaching the western hemisphere; these will need to be monitored for any potential lift-offs.

**Solar Wind / Geomagnetic Activity:** Solar winds are expected to remain elevated today (21st), and probably temporarily becoming strong, under the influence of CH82, before slowly declining through the following days. Geomagnetic activity is forecast to be Quiet to Unsettled (Kp 0-3), but with isolated Active (Kp 4) periods likely today and overnight.

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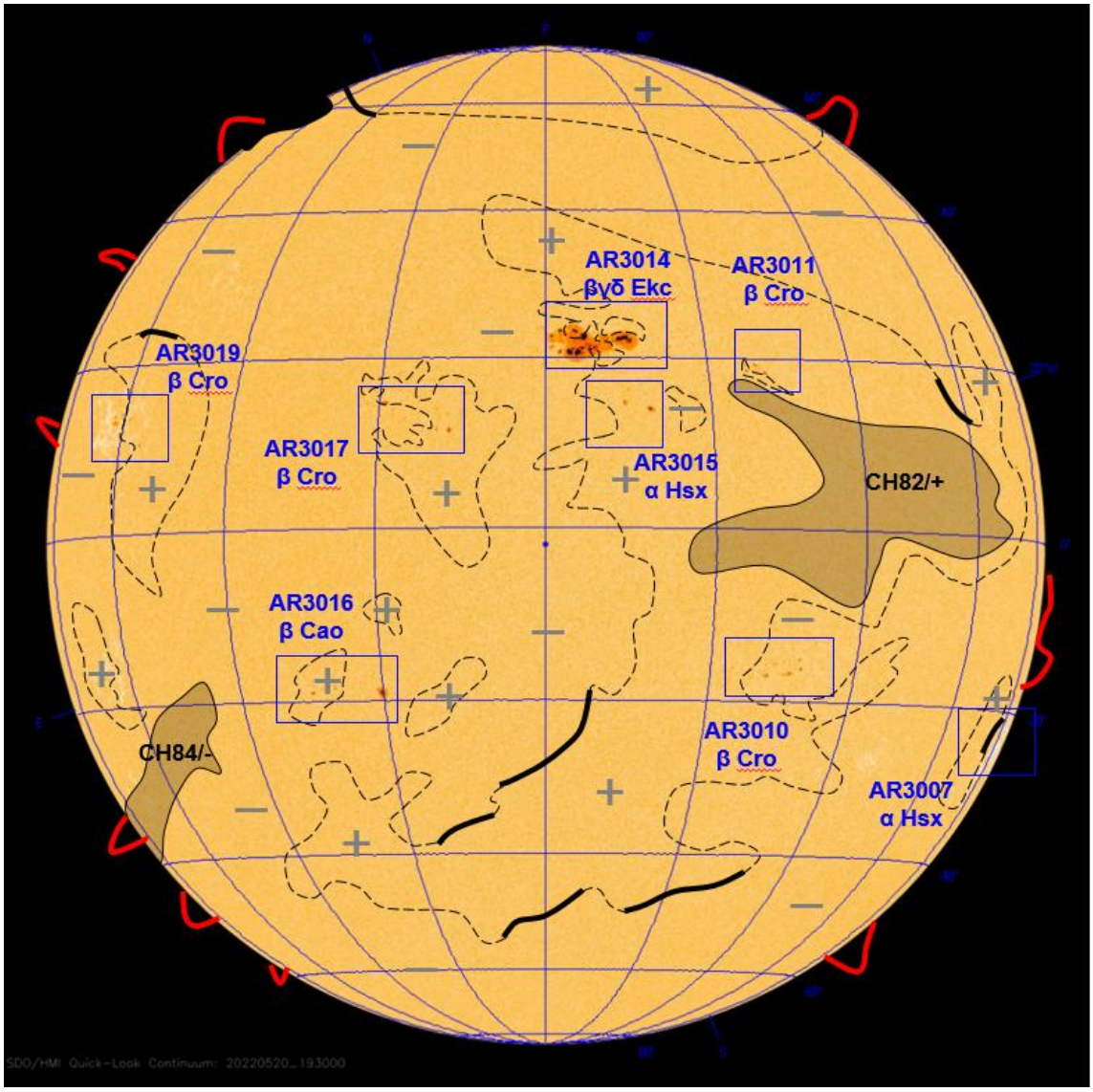
**Energetic Particles / Solar Radiation:** The high energy proton flux (greater than 10 MeV) is expected to be at Background levels during this period, but with a Slight Chance of flux reaching S1, should any notable flares occur. The high energy electron flux (greater than 2 MeV) is forecast to remain at Background to moderate levels at first, but with an increasing chance of the diurnal peak reaching High levels later in the period. The 24-hour electron fluence is expected to remain below the Active (1e8 integrated pfu) threshold during the forecast period, despite a rising trend.

**Figure 1. Solar Analysis Valid 20/1930 UTC.**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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# Met Office Space Weather Technical Forecast

## Geomagnetic Storms:

Solar winds are currently elevated to strong, under the influence of the high speed stream (HSS) from CH82. Little change is expected through day 1 (21st), before the HSS declines from tomorrow. By day 4 (24th) slightly elevated solar wind speeds are expected, as no other significant enhancement to the solar wind is forecast.

Geomagnetic activity is forecast to be Quiet to Unsettled (Kp 0-3), but with isolated Active (Kp 4) periods likely today and overnight, and a chance of a Minor/G1 geomagnetic storm early today.

| Geo-Magnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | No | 20 | 10 | 5 | 1 |
| Strong | G3 | No | 1 | 1 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

## Radio Blackouts - X-Ray Flares:

There are eight sunspot regions on the Earth-facing disc, although AR3007 will soon rotate behind the western limb and previous AR3010 is now AR3011. AR3010 has developed over the past few hours, but remains small in size and magnetically simple, just as AR3011. AR3014 remains the largest and the most complex region but despite multiple delta spots and a large penumbra, it appears mature and stable. Region AR3019 is showing signs of slight development but remains magnetically simple. All other regions are small and stable, or gradually declining. Solar activity has been Moderate in the last 24 hours with an isolated impulsive M-class flare observed, peaking at 20/0745 UTC from AR3014 Ekc/Beta-Gamma-Delta. The background x-ray activity is at low C-class levels, but with frequent higher level C-class flares occurring from various regions, especially from AR3011 and AR3019.

Moderate activity is currently likely to continue with further M-flares (R1-R2 Blackout) likely, and a slight chance of X-Class flares. The main source of the activity is likely to be from AR3014, although some significant flaring is also possible from AR3019. New regions may also rotate onto the visible disc later in the forecast period.

| X Ray Flares | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|

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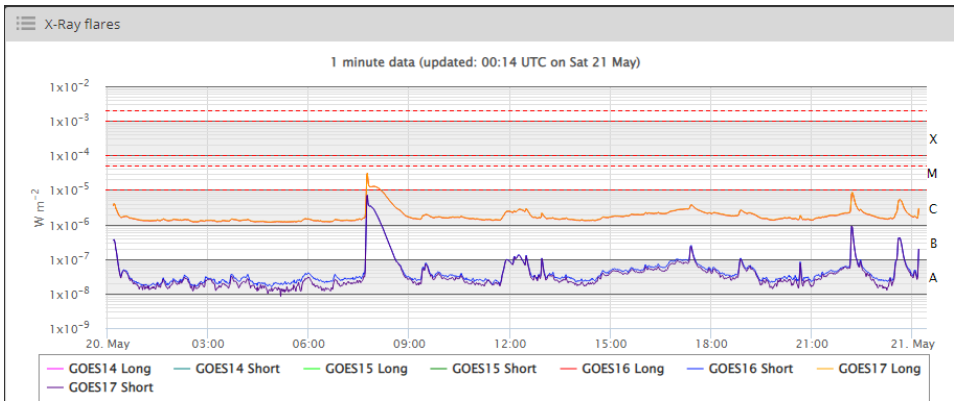
| Probability | | | (%) | (%) | (%) | (%) |
|---|---|---|---|---|---|---|
| **Active** | **R1-R2 M Class** | Yes | 50 | 50 | 50 | 50 |
| **Very Active** | **R3 to R5 X Class** | No | 10 | 10 | 10 | 10 |

**Figure 3: GOES-16 X-Ray flares during the past 24 hours.**




## Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is at background levels and is expected to remain at that level through the period. However, there is a slight chance of an S1 or greater event during the forecast period. This is mainly from AR3014, which is a large and magnetically very complex sunspot region that is now within the western hemisphere. M-class flares are likely from this region, with a slight chance of X-class flares.

| Radiation Storms Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ S1** | No | 10 | 10 | 10 | 10 |
| **Very Active** | **≥ S3 *** | No | 1 | 1 | 1 | 1 |
| * S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$) | | | | | | |

**Figure 4: AR3014 SDO Intensitygram (left) and magnetogram (right).**

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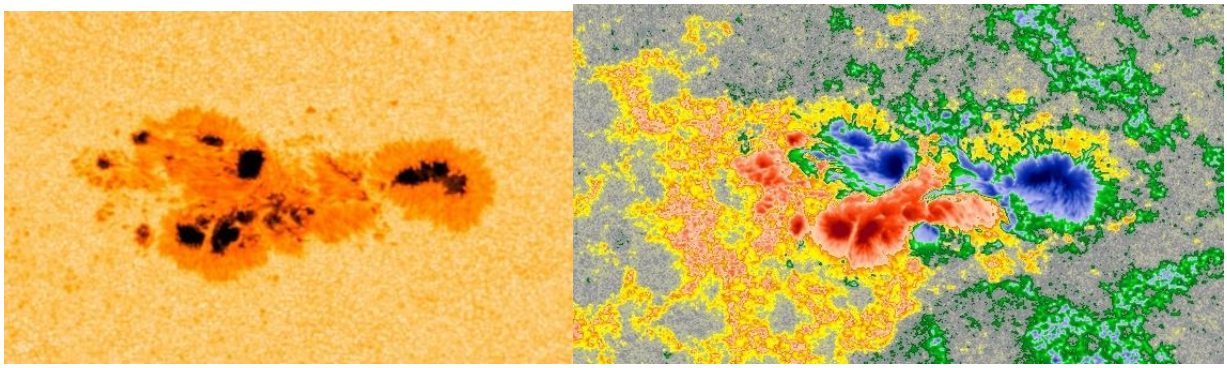


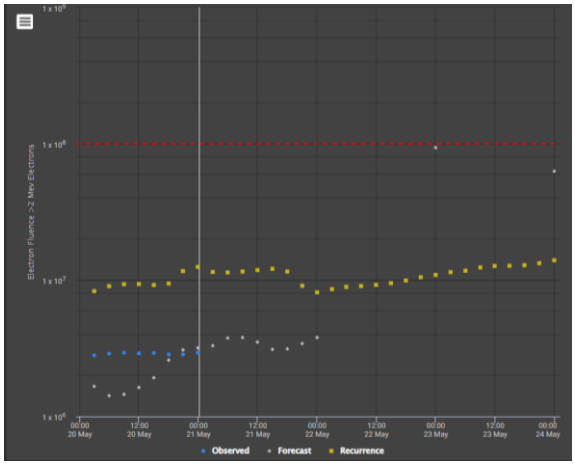
## High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2 MeV) as measured by GOES-16 at GEO is currently at background to moderate levels. Through the forecast period a gradually rising trend is expected, due to the prolonged effects of the current elevated solar wind speeds. Therefore there is a gradually increasing chance of seeing the flux exceed the High (1000 pfu) level during diurnal peaks.

Corresponding electron fluence is likely to show a gradual upward trend through the period. However, the fluence is likely to remain below the Active (1e8 integrated pfu) threshold.

| GEO Electron Environment | Level ($cm^{-2}$ $sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability (Exceedance) | | | (%) | (%) | (%) | (%) |
| Active | ≥ 2 MeV ≥ $1x10^8$ | No | 1 | 10 | 20 | 40 |
| Very Active | ≥ 2 MeV ≥ $1x10^9$ | No | 1 | 1 | 1 | 1 |

**Figure 5: Met Office REFM model, which is considered to be offering good guidance.**

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